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FIRE RETARDANT VISCOSITY MEASURED BY MODIFIED MARSH FUNNEL

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ABSTRACT

This paper describes modifications necessary to make a Marsh Funnel suitable for measuring viscosities of chemical fire retardants in the field.

Use of chemical retardants in forest fire suppression is now a firmly established procedure. Proper viscosity for each retardant material and each type of use is necessary for most effective application. The viscosity of fire retardants is extremely difficult to estimate visually; most viscometers capable of rendering reliable measurements are expensive, and cannot be used in rough field situations.

The desirable viscosity of a fire retardant depends on the job for which it will be used. Retardants applied from ground equipment must be viscous enough to build up a thick layer on the fuel, but must remain easy to pump. Those applied from air tankers must be more viscous in order to cling together during the drop and to reach and adhere to the fuel properly.

To provide the measurements of viscosity needed in the field, a Marsh Funnel[1] can be modified for use with all commonly used fire retardants. This funnel has a diameter of 6 inches at the top, and a total length of 12 inches. The 10-mesh screen that covers half of the top should not be used as it may change the structure of the retardant.

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[1] The Marsh Funnel is usually used to measure viscosity of oil well "drilling muds" and is manufactured by the Baroid Division, National Lead Co., P.O. Box 1675, Houston, Texas. Mention of trade or brand names is solely for identification and does not imply endorsement of products mentioned, nor does it imply nonendorsement of unnamed products.

Viscosity is measured by agitating the fluid, pouring it into the funnel up to the screen, and recording the time in minutes and seconds necessary for 1 quart to pass through. Several fire-retardant materials have a much higher viscosity than do the drilling muds for which the funnel was designed; thus the orifice, or tip, is not large enough to accommodate these retardants. However, if the original tip is removed and replaced by a larger one, satisfactory determinations of viscosity can be made in the field. The large tip is used alone for the thicker materials, or the original one can be reinserted for measuring the thinner, less viscous materials.

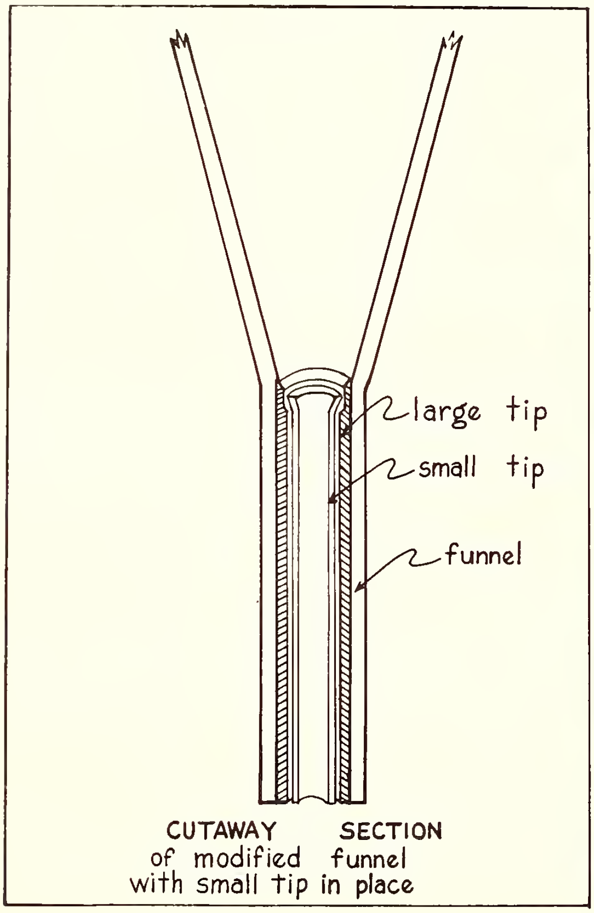

Figure 1.--Cutaway section of the modified Marsh Funnel with small tip in place.

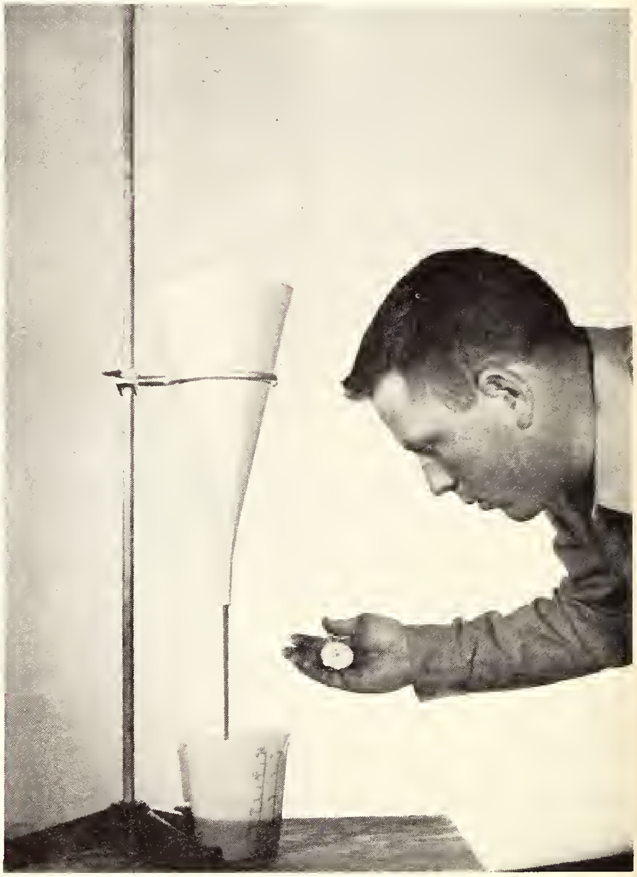

Figure 2.--Measuring viscosity with modified Marsh Funnel.

METHOD OF DETERMINING VISCOSITY

There is no single correlation between calibration of the Marsh Funnel and that of rotational viscometers (e.g., Brookfield) for all retardants; the two types of instruments respond differently to such characteristics as rate of gelation, gel strength, thixotropy, and density. Consequently, the Marsh Funnel must be calibrated for each fire-retardant material. The following method established the relation between viscosity measured in centipoises and in "Marsh Funnel seconds":

1. We mixed samples of each retardant at several viscosity levels. The retardant material stood untouched for 15 to 18 hours after mixing.

2. A Brookfield model LVF viscometer, at 60 r.p.m. and using spindle 4 (spindle 2 for Phos-Chek 259), rendered viscosity measurements in centipoise units. The readings were taken after the spindle had turned for 1 minute in the sample.[2]

3. From the same sample we filled the Marsh Funnel to the screen and measured the time in seconds required for 1 quart to run out the bottom into a graduated beaker. Measurements were made using both the large- and small-sized tips.

4. Three replications of both Brookfield viscometer and Marsh Funnel measurements showed close reproducibility; the data were not statistically treated. Data for the various samples were plotted, and the best curve was fitted to these points by the method of least squares.[3]

Table 1 shows the relation between viscosities measured by the Brookfield viscometer and the "Marsh Funnel seconds" equivalents.

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[2] Gelgard thinned rapidly when subjected to the revolving spindle; this made necessary a 15-second turning time before reading.

[3] The linear relation between actual viscosity and Marsh Funnel time for Phos-Chek 259 permitted the equation for the best possible curve to be solved by a computer method of least squares for fitting polynomial curves. This method of curve fitting could not be used for most fire retardants because the curves did not approximate polynomials, but tended to be exponential functions.

Table 1.--Relation of Marsh Funnel time to viscosity as measured by the Brookfield Viscometer Model LVF, at 60 r.p.m.

Time for 1 quart to flow through funnel[1]		Fire-retardant material								
		Gelgard M		Gelgard F		Phos-Chek		Bentonite	Fire-Trol 100	
						202	259			
		Large tip	Small tip	Large tip	Small tip	Large tip	Small tip	Large tip	Large tip	Small tip
Min.	Sec.	Centipoise								
0	15							500	930	
0	30		20		20		5	1875	2140	
1	00	550	170	625	153	1000	136	2450	2800	1460
1	30	700	280	780	275	1380	274	2675	2940	1810
2	00	820	370	883	378	1640	413	2815		1960
2	30	908	442	962	471	1855		2925		
3	00	980	508	1038	550	2010		3005		
4	00	1098	616	1180	672	2315				
5	00	1188		1316		2560				
6	00	1264		1444		2760				
7	00	1327				2950				
8	00	1387								

[1] Funnel must be FULL to screen before testing begins.

INSTRUCTIONS FOR MODIFICATION AND USE

A packet to help field personnel modify and use a Marsh Funnel in measuring viscosity is available for free distribution by requesting a MARSH FUNNEL PACKET from

Northern Forest Fire Laboratory
U.S. Forest Service
Missoula, Montana 59801

The packet contains

1. Instructions for modification
2. A drawing of the modification
3. Instructions for using table 1
4. Table 1: For each 5 seconds through 3 minutes
   For each 10 seconds beyond 3 minutes